

Preface

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Giacomo Chiesa *Editor*

# Bioclimatic Approaches in Urban and Building Design



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Editor

# Bioclimatic Approaches in Urban and Building Design

With a Keynote Chapter by Prof. Mario Grosso



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# Preface

The idea to write this book first emerged between 2008 and 2010, when as an early stage researcher I was trying to understand the multifaceted approach to bioclimatic design developed over recent decades. However, it was only on the recent retirement of Prof. Mario Grosso, who has been my tutor, colleague and friend over the last 10 years as well as the leading expert at the Politecnico di Torino on bioclimatic architectural design thanks to his 48 years of experience in the field, that the original idea was transformed into reality. This publication aims at defining a critical vision of bioclimatic and green design by combining a large set of contributions which focus on international and Italian approaches, including a key chapter by Mario about his research experience.

This book is targeted at architects, engineers, scientists and building designers who want to learn more about bioclimatic design. It focusses on the correlations between climate and architecture in the past, present and future based on the experiences of researchers in the field. The specific proposed analysis is grounded in the architectural technology approach and adopts a performance-driven methodology which is perfectly compatible with advanced digital design visions. This approach to bioregionalism, which has included from the very beginning the adoption of passive, low and renewable energy systems for the built environment, was and is the object of continuous innovation since it is an area where different disciplines and research fields pool their knowledge in the direction of a sustainable and green design vision. In particular, architectural technology is the research field that since the 70s has introduced bioclimatic design approaches to Italian architectural culture, thus uniting various fields of research. Consequently, several authors in this book come from this field. Although the earliest environmentalist discussions concentrated on the relationship between energy and the environment, debates now include the need to curb negative impacts of climate change and local overheating phenomena, such as urban heat islands, together with the need to develop and think of building and urban renovations in a comprehensive and critical design vision. Furthermore, even if bioclimatic architecture is an approach that has been with us at least since the 60s of the last century, climate-related approaches to building/urban design and full integration between passive systems

and envelope elements are still more one-offs rather than the norm. The inclusion of a full urban dimension and the expansion of digital tools and computational power are other essential technological and innovational aspects of current green design visions. It is clear that these new challenges require attentive readings and critical discussion. Hence, the book is more informative than highly focussed in detailed calculation methodologies. It aims at correlating current multi-visions of the bioclimatic topic by describing open issues and by referring to authors' specific publications that delve more deeply into certain topics. The large number of contributions is an essential aspect of the book because bioclimatic design, after more than 60 years of existence, is characterised by a complex multi-voiced vision. For this reason, this work sets out to overcome certain shortcomings in arriving at shared cultural-definitions of some aspects of bioclimatic design and also to define potential connections between specific outcomes of recent researches.

The book is divided into six parts:

- I. Environmental and Technological Design Framework;
- II. Roots and Evolution;
- III. Environmental Building Design Concepts and Methods;
- IV. Urban Environmental Design;
- V. Passive Climate Control Strategies and Technologies;
- VI. Technological Representation and Digital Innovation.

In particular, Part I focusses on analysing the bioclimatic design framework and approaches. The first chapter introduces some current open issues on sustainable design, e.g. the anthropogenic background which includes climate change, urban dimensions and growth in cooling needs. The correlation between certain aspects of technological and environmental research is also introduced at this early stage. The keynote chapter written by Mario Grosso is an essential contribution that defines the main topics in bioclimatic architectural design and practice over 50 years. Thanks to the autobiographic experience here reported, it is possible to debate on the evolution of bioclimatic and technological-connected design issues. The contribution of Rossana Raiteri and Fausto Novi helps to detail the technological vision in bioclimatic and sustainable design by giving a critical conceptualisation of the issue. The role of technological research, which includes bioclimatic design, is connected with the theme of the environment. Fabrizio Tucci details the current strategies and requirements which underpin current and future bioclimatic and environmental design issues, including judgment criteria. The chapter discusses bioclimatic design opportunities and possibilities in the context of currently open environmental issues. Mat Santamouris discusses the main current and future issues in the built environment as he focusses on climate change, the increase in world population, energy poverty and future energy needs by analysing building consumption trends. The chapter also deals with the urban dimension and connected challenges in energy and environmental technological terms.

Part II mainly analyses the origins and evolution of bioclimatic architecture. The chapter by Mario Grosso includes a study of international references and key figures in bioclimatic architecture, from the origins. Maria Luisa Germanà analyses past, present and future aspects of bioclimatic design. She deals with rural and urban built environments as a continuum and proposes a technological reading, which overcomes the often opposing approaches to urban and rural environments in the past. Furthermore, she critically reflects on current bioclimatic approaches and vernacular characters from an epistemological point of view. The contribution of Michela Toni details bioclimatic approaches at different design scales thanks to her personal research experience from the 70s, when bioclimatic design was an emerging issue, until current technological research pulsations. The chapter by Adriano Magliocco analyses the essential relationship between bioclimatic design and environmental impacts by critically revisiting famous architectural urban design processes developed over the last four decades. The past present and future impacts of bioclimatic design in solar cities are examined. Special attention is given to the contradictions and the oversimplifications of bioclimatic approaches that aim towards a solely energy-driven vision, thus running the risk of losing the human dimension in sustainable building design.

Part III deals with environmental and bioclimatic design concepts and methodologies. Maria Cristina Forlani analyses recent energy challenges in building design, including correlated ambiguous implications. If the field of architecture is to face up to its contemporary responsibilities and accept the fundamental importance of climate issues in design choices, design practice must systematically and comprehensively take into consideration embodied energy, waste and emissions. Andrea Giachetta and Maria Canepa propose a critical vision of the ecological cultural approach to building design. They discuss the spread of sustainable issues in architecture that have generated positive results, but have also produced a simplification in cultural approaches with the consequent risk to pursue false results. Rossella Franchino analyses the cultural landscape domain in Mediterranean areas, re-balancing antropogenic issues with natural ones and analysing the connected bioclimatic implications. Consuelo Nava addresses the new quality of building design and considers advances in sustainable design issues including new paradigms which are able to use to great effect advanced information, resource management and KET in the attempt to develop an agile design approach. The critical discussion includes a reflection on resilient scenarios including sample design applications and experimental prototyping with additive manufacturing. Ernesto Antonini talks about bioclimatic connections with various environmental impacts, dealing with the embodied energy dimension. In particular, his chapter analyses EPBD implications together with other sustainable rating systems including energy and life-cycle assessment impacts.

Part IV includes contributions which focus on the environmental design aspects at urban scale. The urban dimension is one of the main contemporary challenges if we consider the need to develop sustainable and resilient cities and the continuous innovations in modelling tools that support bioclimatic and sustainable design actions at urban scale. In particular, Alessandra Battisti deals with requalification

processes in urban open spaces to align with EU guidelines on climate change. The chapter focusses on materials, urban vegetation, water, shading and other environmental and technological design aspects that connect energy needs and bioclimatic comfort issues with urban morphologies. Renata Valente studies environmental design implications for open urban spaces in consideration of the complexity of environmental issues which correlate both scientific and human studies. The contribution includes an analysis on flooding events and other climate change challenges and suggests resilient regeneration approaches for urban districts in an adaptive design vision. The contribution of Elena Garcia-Nevado and Benoit Beckers reports an ongoing study on the connection between architecture and urban physics, a new research area that is expected to grow in the coming years. In relation to advanced monitoring approaches and thanks to the increase in the computational power of simulation digital tools, the authors study radiative exchanges in dense urban areas and support the development of a simulated advanced thermography design approach. Focussing on different aspects of urban microclimatic design, Valentina Dessi describes on urban materials and water usage and management at urban and district scale in an adaptive design approach. The evaporative cooling potential of water in outdoor open spaces is investigated with international examples given and the community role that urban structures may play in citizen involvement is described.

Part V deals in particular with climate and passive control strategies and technologies. A chapter by Claude-Alain Roulet introduces passive means that can control and improve indoor thermal comfort in low-energy buildings. Taking into consideration passive architectural systems and active technologies, the chapter examines the issues related to passive space cooling and heating to reach indoor environmental quality without consuming energy, thanks to proper architectural design measures. The chapter by Giacomo Chiesa reports a focused study on the development of geo-climatic applicability indicators that support local choices among different low-energy cooling technologies. Climate-correlated maps that define the early design potential of different passive dissipative technologies are reported for the Italian peninsula including climate change implications. Katia Perini analyses the impact of greening building envelope technologies and considers the potential of greenery to improve microclimatic conditions by reducing space cooling energy demands and improving outdoor comfort. Vertical greening systems are studied in detail from an economic and environmental point of view, including biomaterial development. Giovanni Scudo deals with the potential contribution of bioclimatic design approaches to developing liveable spaces considering multi-comfort issues and guaranteeing natural rhythms. Green technologies are also analysed considering their ability in improving urban microclimates, by proposing a toolbox for preliminary green design.

Part VI introduces aspects of digital innovation and technological representation in bioclimatic design. Chiara Tonelli investigates the implications that digital and energy transitions have on our evolving society and building architecture. This chapter focusses on the potential implications that smart technologies may have on our houses and cities. Furthermore, the chapter written by Maria Antonietta Esposito

and Filippo Bosi studies the impact of BIM and digital innovation aspects on the green design approach and describes new industrial processes. The analyses include an historical study of bioclimatic implications from the 60s onwards and connects them with the related development of calculation methodologies and tools that define energy and physical environmental simulation. The chapter considers the evolution from CAD to BIM platforms in relation to green design issues. Alessandro Rogora discusses simplified tools and methodologies to represent energy issues connected to architectural design projects. Given that, architects are responsible for construction and design processes, the possibility to have proper design tools and simulation software is essential to support the development of counterintuitive approaches allowing to achieve comfort conditions, since architectural design is the combination of both technical and artistic challenges. The contribution of Rosa Romano focusses on reviewing kinetic adaptive facades. The development of smart and automatic control systems allows for the development of a new approach to building envelope in which the façade itself becomes a movable and adaptable system which is able to react to environmental conditions and optimise indoor comfort.

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